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ABSTRACT

This paper presents a case history of an experienced special education teacher for the purpose of describing the nature of the teacher's knowledge structures. Data were gathered from interviews, stimulated recall of videotapes, and descriptions of her classroom. Similarities were found between her knowledge structures and those of other expert teachers. Data from studies by cognitive psychologists have indicated that expertise is the product of interactions between knowledge structures and processing abilities. Descriptions are given of this teacher's community, school, classroom, and the teacher herself. The investigation found that this teacher, like other expert teachers, had a large repertoire of highly flexible routines that required little or no monitoring or explanation because the students were familiar with them. It was also found that the expert teacher's knowledge structures are highly contextual and tied both to tasks that must be accomplished and to the events of the particular classroom. Serious questions were raised by the study about the kinds of constraints that are placed on teachers, which may be more characteristic of special education classes than of regular classes. (JD)

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TOWARD A MODEL OF EXPERT TEACHERS' KNOWLEDGE STRUCTURES: THE IDENTIFICATION OF COMMON FEATURES ACROSS STUDIES

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Paper presented at 1990 meeting of
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INTRODUCTION

The purpose of this paper is to describe the knowledge structures of a special education teacher. She was asked to participate in this project because she had been identified as an outstanding student in her masters' program several years before. As we analyzed the data from interviews, stimulated recall of videotapes and descriptions of her classrooms, the structure of her pedagogical knowledge gradually emerged. As these structures became visible, we found that the features of her knowledge structures bore a striking resemblance to the structures of experts in other fields. It was also surprising to find that there were similarities between her knowledge structures and those of other expert teachers.

Cognitive psychologists have discovered that there are qualitative differences in the way experts and novices process information. The data from these studies indicate that expertise is the product of interactions between knowledge structures and processing abilities. According to Glaser (1987), "Expert performance is characterized by rapid access to an organized body of conceptual and procedural knowledge." (p.81) However mere knowledge alone will not result in superior performance. Experts organize knowledge using schema, which Glaser defines as," a modifiable information structure that represents generic structures of concepts stored in memory." (1987, p.88)

Recently researchers have begun to study the differences between expert and novice teachers. Leinhardt and Greeno (1986)

propose that skilled teachers have knowledge structures in which pedagogical knowledge is organized into readily accessed schema. These schemata were visualized as hierarchal structures in which supporting routines were nested. When a particular schemata was activated it also activated all the subroutines.

These investigators found that expert teachers have a large repertoire of routines. These routines are highly flexible and require little or no monitoring or explanation because the students as well as the teachers are familiar with them. In contrast novice teachers have not developed routines. This means that novice teachers require more time to teach a lesson because they must explain the procedure for each segment of instruction.

One of the most salient points of the literature on expert teachers is the finding that teachers' knowledge structures are highly contextual. That is, they are tied to the tasks they need to accomplish and the events of a particular classroom (Carter and Doyle, 1989). Therefore, the knowledge structures of an expert teacher cannot be fully understood apart from her interactions with students in the classroom. With this point in mind, we would like to describe the community, the school, the classroom, the students, and the teacher herself before moving on to the more technical aspects of this case study.

THE TEACHER

Anne, the teacher in our study came into teaching rather late in life. She had been an attorney for ten years, but found that she disliked the confrontational nature of the legal

profession. She turned to teaching because it offered her a chance to pursue her interest in "how people learn". Therefore, she decided to pursue a master's degree in special education.

After she completed her master's degree Anne and her husband moved to Alaska. There she taught a self-contained primary class that was noncategorical, that is, the students were identified for special education but were not labelled as learning-disabled, emotionally disturbed or mentally retarded. Even though the students differed in their exceptionalities, they were all working on the same skills and she was able to group them homogeneously. She really liked the job, but she did not like Alaska so she and her husband returned to the university community where they had lived previously.

After they returned Anne taught in a private school for learning disabled students. This school was well known for its highly structured approach toward remediating learning deficits. Thus Anne was able to practice her skills in classroom and instructional management.

THE COMMUNITY AND THE SCHOOL

At the time of our study Anne taught in a elementary school located in a small town. Although this town is only twenty miles from the university that she attended, its feeling is more rural and less sophisticated.

The elementary school in which Anne taught was located on the edge of town. Even though the building is an old one, it has a warm, homey quality that is lacking in many more modern school

buildings. Anne's classroom was downstairs, a little out of the "mainstream" of the school.

The classroom itself was sunny and cheerful. It had various areas which were labelled "quiet area" or "the learning center". Posted all around the room were classroom rules and protocols. At the front of the room there was a blackboard where Anne had written the day and date and a list of five things all the students had to work on. Every day Anne went over each task and gave any special instructions that the students needed to know.

The most striking aspect of Anne's classroom was her effort to provide structure. The physical arrangement and the many rules posted around the room were all aimed at meeting the need for structure of these students. These were the physical reminders of her belief that special education students perform best when they know what is expected of them.

THE STUDENTS

The first impression upon entering Anne's classroom was that the students varied greatly in size. The students ranged in age from seven through thirteen and from grade two to grade five. The class was labelled "LD self-contained," however, it was clearly much more of a non-categorical class. The previous year it had been labelled Emotionally Disturbed/Learning Disabled. It still had two ED students that Anne believed were autistic.

Anne reported that she had three children who were fifth grade age who were working anywhere from the second to the fourth grade level. She had four fourth graders who were all working on

a second grade level and one third grader who was working at about a first grade level. She also had two second graders, one of whom was working on a first grade level, and one who was working on a kindergarten level. She reported no serious behavior problems other than just hyperactivity, except for the autistic child, who had some self-stimulatory behavior. In addition he was not really very well toilet-trained and was echolalic and nonresponsive.

METHODOLOGY

The case study methodology was chosen for this investigation. First, evidence was gathered from several sources in order to achieve a multiple perspective or triangulation of data sources. When triangulation is used in a case study it becomes more rigorous and therefore more credible.

Our study used a second kind of triangulation. The data was gathered by three different persons or teams of persons. An initial interview with the teacher was done by two of the three principal investigators. The description was done by one researcher and the videotaping and stimulated recall interview was done by another.

The following methods of data collection were used in this study:

- interviews-the teacher was interviewed before videotaping began and after data analysis as a check on the accuracy of the data.

- classroom description-one of the researchers observed the classroom on several different occasions and wrote descriptions of the classroom and its activities.
- stimulated recall-the teacher was videotaped teaching four different lessons. One of the researchers replayed the videotape of a lesson and asked the teacher to stop it any time she had a comment. The researcher also stopped the tape at intervals and asked the teacher what she was thinking about during a particular instructional event. This interview was audiotaped for future transcription and data analysis.

Thus this case study used both a structured and unstructured format of stimulated recall. The teacher was instructed to stop the tape at any time that she had a comment. In addition, the researcher stopped the tape and asked the following kinds of questions:

"What were you thinking when that happened?" or

"What was running through your mind?"

It is important to note that these methods were used simultaneously, that is, the videotape was viewed only once by the researcher and the teacher together.

DATA ANALYSIS

The following data analysis procedures were used :

- analysis of the transcripts of the audiotapes of stimulated recall interviews.

- development of categories by the two researchers independently of one another.
- review of the videotape in order to reach a consensus on categories.
- coding of the transcripts according to categories of teacher thinking.
- development of a model of teacher knowledge structures.

After the data was collected, the transcripts of the stimulated recall audiotapes were typed using a word processor. Because the transcripts were saved on a computer disk, it was possible to continue to make changes and corrections. This proved to be very helpful due to the emergent nature of the case study methodology.

Both researchers were involved in analyzing the data. We began looking at the data in terms of the codes developed for the Beginning Teachers Assistance Program (BTAP). The BTAP instrument was developed to evaluate the teaching behavior of beginning teachers. It turned out that the BTAP code did not accurately describe the teaching behavior of the teacher in our case study. For example, BTAP "Questioning Behavior" (QB) is defined as, "Teacher asks questions of the group or individual learners." Although Anne asked questions, they were really cues for students to respond to a practice activity. For example, in the phonics lesson, she says, "Sound that one out", followed by, "What does this part of the word say?" "What does the whole word say?" Though technically questions, these sentences function

more like commands or cues to respond. Thus, we found it necessary to develop a coding system that more accurately reflected this teacher's instructional procedures.

Therefore, on the next pass through the transcripts, the researchers developed their own category and coding system independently of one another. Then they compared the two coding systems. It turned out that the two systems were similar in most respects. For example, they both saw many instances in which the teacher provided feedback to the students. Eventually this behavior was categorized as "checking and correcting" because the teacher often used these words to describe what she was doing.

A MODEL OF A TEACHER'S KNOWLEDGE STRUCTURES

While analyzing the stimulated recall transcripts we noted that there were two kinds of categories which we visualized at two distinct levels. One of these levels seemed more basic and was tied to the teacher's pedagogical knowledge, her understanding of her students, and the influence of the setting on her teaching.

Her pedagogical knowledge was derived primarily from the content of her courses at the university. It was there that she learned about direct instruction and the teacher effectiveness research. Her teaching experience was another source of this knowledge particularly the year spent teaching in a private school where the classes were highly structured.

Her knowledge about the students was derived from two sources. The first, was from courses about characteristics of

exceptional children at her university, and the second was from her experience in teaching exceptional children. Her knowledge of the setting was derived from direct observation.

This knowledge base formed the foundation of Anne's teaching and was thus called the fundamental level. It was made up of the following categories:

- pedagogical principles
- constraints of the setting, and
- learner characteristics.

These three factors played a key role in the way Anne structured her instruction and classroom management.

A second level related more strongly to the way instruction was carried out and consisted of behaviors that were well-learned and often automatic. We began to refer to this structure as the operational level. The categories in this level were as follow:

- classroom rules and procedures,
- checking and correcting
- drill, practice, and cuing,
- monitoring, analyzing, and reviewing, and
- modeling the target behavior

An intermediary level mediated between the operational level and the fundamental level. This level was made up of skills and strategies, the teacher's main instructional objective.

The entire structure provides a model or heuristic that helped us visualize the knowledge structures of this expert teacher. The word "model" is used advisedly and is not intended

to suggest that it describes other than the knowledge structures of this teacher.

PEDAGOGICAL PRINCIPLES

Anne's pedagogical principles were the direct outgrowth of her training in her master's program. They were as follows:

o Direct instruction techniques and materials

Anne defines direct instruction as a "fast paced...uh...involves keeping a high percentage of responses from all the children. In other words, you might have a child sitting over here because it's not his turn...um...so you try to keep all the children involved with the things...and...um...you're aiming at a specific skill...uh...that's what direct instruction is to me."

o Relating research findings to instruction,

About relating research findings to instruction she had this to say, "I read a lot in journals and particularly "Exceptional Children"..um...and so I pick up a lot of things that I do from reading journals...um if I run across...well, like last year when I taught in another school I didn't know how to teach reading comprehension so, I went back through journals and found articles and you know and basically had the direct instruction focus I was looking for. Techniques that broke skills down and specifically taught skills as opposed to directed listening, thinking activities, which I like."

o Adapting materials to the needs of the student

An example of the way Anne adapts materials to the needs of the student is found in the stimulated recall of a reading

lesson. Anne says, "I'm not doing the whole study skill but, part of the study skill is that you generate questions in advance of reading." And further, "I kind of re-phrased the question for him...and that's important to do for children who don't know how to ask questions."

o Relating new information to something they know

We find an example of this in an excerpt from a stimulated recall transcript:

Anne:Uh,..I am just trying to set them up to know what we are going to be working on...and trying to tie it into some stuff that we've done in the past.

LEARNER CHARACTERISTICS

In the stimulated recall interviews Anne referred frequently to the kind of exceptionality of each child and to the kinds of behaviors that characterize that particular exceptionality. The following excerpt is an example, "

"He was still not participating in any of the unison responses, he was clearly aware of what was going on and that when I called on him, he was able to make a relevant, appropriate comment in most cases. So, I thought he did a real nice job of participating. Maybe it is possible to integrate an autistic child into a LD class."

She was also aware of the kinds tasks each student was able to perform and those with which they had difficulty. The excerpt that follows is an example:

"Richard, that child has a tendency to read words, using context. He understands what he reads pretty well, but he has a tendency to read words, has a tendency to guess at words, number one, using context. He understands what he reads pretty well, but he has a tendency to guess at what the word is and just use the beginning sounds of the words."

CONSTRAINTS OF THE SETTING

We have already alluded to the way constraints of the setting limited what Anne could accomplish. The diversity of the students made it necessary that Anne provide a solid structure in which the students could learn. Other factors such as an aide who refused to enforce new classroom rules made it more difficult for her. Even though Anne was an expert teacher it was difficult for her to do her best teaching because of the constraints of the setting in which she worked. There were four kinds of constraints that operated on the structure of Anne's teaching.

o Diversity of students by age and learning characteristics

This was a tremendous obstacle to Anne's teaching. The description of the students ages and level of abilities found earlier in this paper provides a vivid picture of some of the obstacles Anne had to overcome in order to bring structure to this class.

o Previous structure

Anne has also experienced difficulty in taking over the class from a previous teacher. She reports, "I'm in an odd situation because this class has been here; I'm the only person

who's new in the class. The aide was here, all the children were here, (laughs) and then I came into the class...so it's been sort of an interesting experience, trying to fit it. It's kind of like substitute teacher syndrome; they're always telling me "we don't do it that way in here."

o Outside sources

The pull-out schedule, holidays, and other special events had also constrained Anne's teaching. Mainstreaming had been another source of disturbance for Anne. The students varied in the degree to which they were mainstreamed into regular classrooms. They were all mainstreamed in gym and music. One of them was mainstreamed for the entire afternoon, for science and social studies and one of the younger children is mainstreamed for science. Anne sees a certain irony in the fact that they were placed in a self-contained class because they weren't making it in the regular class and yet the constant pressure to mainstream prevented some students from the benefits derived from a self-contained class.

o The regular curriculum

Anne was charged with teaching the regular curriculum whenever possible. The goal of the school administration was to return students in self-contained classes to regular classrooms as soon as possible. Therefore, if students tested at grade level in any subject Anne was constrained to use the regular curriculum. An example, of this is found in the math lesson we

recorded in which Anne used the math book used in the regular curriculum.

ROUTINES

In order to deal with the many complexities of this classroom, Anne developed a set of routines. This was a tremendous aid to the children because once they learned the routines they knew what was expected of them. The routines that we discovered in Anne's teaching were as follows:

- Monitoring, analyzing, reviewing-assessing strengths and weaknesses of student in order to determine the level of a skill at which a student can perform satisfactorily.
- Rules and procedures-aids devised to maintain classroom order and to assist learning.
- Drill, practice, cuing-activities designed to elicit rapid responses to promote learning.
- Checking and correcting-procedures designed to provide feedback about a learner's performance.
- Modeling-productions by the teacher of the target behavior that serves as a guide to the learner.

Many of these routines were associated with a particular set of materials. For example, the Corrective Reading materials call for fast paced, rapid responses to the teachers' cues. These scripted materials allowed Anne to go on "automatic pilot" so that she could attend to myriad other details.

It was interesting to observe Anne's teaching behavior when she departed from one of these routines. This happened infrequently, however, the following excerpt from the stimulated recall interview illustrates her difficulty with departures from routines.

(Anne gives a description of bamboo.)

Anne: "They really took me by surprise there. I had no idea how to describe bamboo to them and these children, in general, have such a limited exposure to things in the world, that I often stop and try to explain things like that to them. But, I couldn't think of any point of reference. My grandfather raised sugar canes, so I thought maybe he could relate to sugar cane. It was clear that he didn't know what cane was. So, I don't think he got the point. I should have just pointed to the picture and said that's what it looks like."

SKILLS AND STRATEGIES

An intermediary level mediated between the fundamental and the operational level. Anne saw her primary role as one in which her students were taught the skills and strategies that they lacked. In the stimulated recall interviews twenty skills were mentioned ranging from teaching an autistic child to use a tissue when he sneezed to reading comprehension. The following excerpt illustrates this interest in teaching skills:

Anne: "Well, this is to develop phonetic spelling ability. This particular group of kids is not able to spell phonetically, and so it's to this building awareness of the sounds that they hear in the words, and the order that they hear them in."

THE LESSONS

The teacher was video-taped while teaching four different kinds of lessons:

- o a phonics lesson
- o a deductive reasoning lesson (Corrective Reading)
- o a reading lesson (Multipass)
- o a math lesson (regular curriculum)

An analysis of the kinds of routines that characterized each of these lessons revealed differences between them. This was determined by dividing the occurrences of each kind of routine for each lesson by the total number of routines for each lesson. "Drill, practice, and cuing" and "checking and correcting" were the most frequently counted categories over all four lessons, with 32% and 27% respectively. The phonics lesson had the highest frequency of routines of any of the four lessons with a total of twenty nine or 31% of the total number of routines in all four lessons. This was due to the frequent number of "drill, practice, and cuing routines that characterized the phonics lesson. The math lesson was characterized by a high percentage (25%) of "monitoring, analyzing, and reviewing" routines. The Multipass reading lesson had a high percentage of modeling (32%) and a low percentage of "drill, practice, and cuing" (18%). Just

the reverse was true of the deductive reasoning lesson was characterized by a high percentage of "drill, practice , and cuing" (40%) and a low percentage (5%) of modeling.

The differences between lessons are consistent with the kinds of instructional materials chosen for each lesson by the teacher. For example, the Multipass method calls for modeling of the kinds of questions that the teacher wants the student to think about as s/he reads a text. Thus, it is not surprising that the Multipass lesson showed a high percentage of modeling routines nor that the deductive reasoning and the phonics lessons would have a high percentage of "drill, practice, and cuing."

It is interesting to note that the math lesson showed a high percentage of "monitoring, analyzing, and reviewing". This lesson was taken from the regular curriculum and the students had great difficulty in understanding the material. Thus, the teacher found it necessary to review many of the concepts constantly. However, it is also interesting to note that she continued to use a high percentage of both "drill, practice, and cuing" (29%) and "checking and correcting" (29%). This is consistent with her belief in direct instruction as an important "pedagogical principle."

KNOWLEDGE STRUCTURES OF EXPERTS

One of the most interesting aspects of this study of a teacher's knowledge structures is the similarity of its features to the findings of other studies of expertise. In a review of these studies Glaser (1987) found several characteristics that

were common to experts in fields as disparate as chess or physics. He found that experts possessed a rich store of content knowledge in their field of expertise. More importantly this knowledge was well-organized making it possible for the expert to gain rapid access to this knowledge base. Glaser (1987) also found that experts possess the ability to recognize large meaningful patterns. This recognition occurs so rapidly that it appears to be intuitive because it has become automatic through repeated practice.

The knowledge of experts is highly procedural and goal oriented. Indeed these procedures or routines are the way in which experts operationalize content knowledge. Expertise does not develop in isolation, but is learned through the demands of a particular task and is highly constrained by the demands of the environment. Thus, it becomes task specific and can be disrupted through the appearance of poorly structured problems.

The methodology employed in this case study allowed us to gain access to a teacher's knowledge structures. We found her to be like other experts in her content knowledge of her field. Furthermore, she could gain ready access to her knowledge store because it was well-organized. Like experts in other fields, her teaching was highly purposeful and goal directed. She had a repertoire of routines that allowed her to attend to the performance of her students during instruction and, at the same time, maintain a rapid pace of instruction. However, this rapid pace broke down when problems arose that could not be solved by

selecting one of her repertoire of routines. This characteristic has also been found to be a feature of the knowledge structures of experts from other fields. (Glaser, 1987)

KNOWLEDGE STRUCTURES OF EXPERT TEACHERS

Routines

We also found Anne to be like expert teachers that have been described in the literature. In her reliance on routines, Anne's teaching was remarkably similar to the teaching found by other investigators of teacher cognition. The earliest studies of teacher's decision-making used the diagnostic/treatment model of clinical problem solving used by physicians. This model presupposes a linear chain of decision-making that results finally in a diagnosis. (Kagan, 1988) However, teaching does not fit this model. The rapid pace of instruction requires teachers to adopt different strategies for problem solving and decision-making. Researchers were surprised to discover that teachers made few decisions while teaching. They found that teachers developed routines to deal with the information overload created by classroom interactions and that teachers make decisions only when these routines break down. (Shavelson and Stern, 1981)

In one influential study of the planning of a single teacher, Yinger (1979) identified instructional activities and routines as the two central aspects of the teacher's planning and instruction. He defined activities and routines as the two central aspects of the teacher's planning and instruction. It became evident to him that activities were a basic unit in

planning instruction. He defined activities as the equivalent of "controlled" behavior because they helped create the setting in which instruction takes place. Routines were a mechanism whereby the teacher was able to establish and regulate these activities.

Recently, a far more complex model of instruction was developed by Leinhardt and Greeno (1986). They hypothesized that skilled teachers possess a well-defined set of schemata that differ in size and level of generality. These schemata were visualized as hierarchal structures in which supporting routines were nested. When a particular schemata was activated, it also activated all of its subroutines. An integrated segment of instruction was called a planning net. For example, when an algorithm in math was presented, it called for a whole network of subroutines with corresponding instructional subgoals.

Leinhardt and Greeno found that teachers need supporting routines to make teaching work. They discovered that, "Routines are small, socially scripted pieces of behavior that are known by both teachers and students." (p.76). Routines reduced Anne's cognitive load and allowed her to attend to other aspects of her students' performance. The following excerpt from a stimulated recall transcript illustrates the way Anne did this:

Teacher: "Sound that one out." (points at vowels)

Researcher: "What was happening there? What were you thinking about?"

"What they're doing, what the materials are doing now are distinguishing between uh..I call them..well,

distinguishing between silent "e" words and you know, words, "cdc" words, is what the materials are working on. But I'm not really thinking about that; I'm thinking about whether or not they're providing the correct responses, and paying particular attention to the vowels; whether or not they're saying the correct sounds for the vowels, only because I have a couple of kids who have a lot of trouble with vowel sounds."

Levels and Domains

In their review of the literature on teacher's thought processes, Clark and Peterson (1986) presented a model of teacher thought and action. They identified two domains of teaching which were called (a) teachers' thought processes and (2) teachers' actions and their observable effects. Teacher's observable effects are well-documented in the research literature, however, it is only recently that methodologies have been developed that are capable of eliciting teachers' thought processes. In the Clark and Peterson model of teaching, the reciprocal nature of the two domains is indicated by a double-headed arrow. Furthermore, they contend that the process of teaching can not be fully understood without examining that way these two domains work in relation to one another.

Lowyck (1984) also discovered that teaching can be divided into separate domains, however, he called the two domains (a) teacher thinking and (b) teacher routines. Teacher thinking is the internal process teachers use to plan and execute

instruction, whereas, teacher routines refer to those behaviors which have become well-learned and automatic. He noted that researchers focused on either teacher thinking or teacher routines which has had the unfortunate effect of splitting the act of teaching into two parts. He calls for a more integrated approach toward studying teacher behavior that describes the way that both kinds of behavior relate to one another.

Another researcher conceived of the structure of teaching in terms of levels. Through open-ended discussions, Elbaz (1983) explored one teacher's practical knowledge of teaching. She supplemented these discussions with observations in the classroom. In a content analysis of these discussions, Elbaz identified three levels of practical knowledge:

- The rule of practice is a brief, clearly formulated statement of what to do or how to do it in the classroom.
- The practical principle is a belief or value that the teacher has gained through preservice training or through experience either inside or outside of the classroom.
- The image is a vision of how this teacher thinks teaching should be.

According to Elbaz, each of the three levels mediates between thought and action. Furthermore, these levels do not function independently of one another but are interrelated and support one another. A statement about a rule of practice may give rise to a practical principle and/or an image of teaching. For example, the teacher's rules about the sequencing of

materials and units are stated not by a principle but by an image of "the rhythm of the school year." (1983, p. 139) In her study of one teacher, Elbaz has developed a much more integrated model of a teacher's practical knowledge.

Although our model is not identical to any others described above, it has some features in common with all of them. For example, the structure of our model of teacher thought was made up of two levels not unlike the levels of the Elbaz model. Her "rule of practice" is similar to our "operational level" and her "practical principles is made up of knowledge derived from experience not unlike our "fundamental level". However, our model does not have any components that correspond to the "images" of her model.

The levels of our model are also similar to the two domains of instruction described by Clark and Peterson"s two domains of instruction, i.e., "teachers' thought processes" and "teachers' actions". It also brings to mind the split between teacher thinking and teacher routines in the research on teaching literature.

The research literature is filled with studies that identify routines as a mechanism that allows teachers to deal with the complexities of teaching. (for example, Shavelson and Stern, 1981; Yinger, 1979; Leinhardt and Greeno, 1986) However, the kinds of routines that are identified differ from study to study. This is not surprising because each classroom is unique. Teachers select routines based on the composition of their

classroom and their experience in teaching different mixes of students.

The routines that the teacher in our study selected were a response to the kind of class she taught. Her preservice training and her inservice experience led her to expect that children with learning problems function best in a structured setting. She had learned from the research literature and her own experience that direct instruction leads to higher learning outcomes than other methods. Thus she integrated direct instruction with behaviorist classroom management techniques to produce her own set of routines.

It was even more important for Anne to use routines because of the constraints of the setting in which she taught. The tremendous diversity of her students and the need to create a new learning environment made her selection of routines crucial to the success of her teaching. Indeed the discovery that the setting imposed considerable constraints on the teacher's ability to carry out her instructional objectives is one the more disturbing findings of our study. The fact that Anne mentioned the constraints frequently in both stimulated recalls and in interviews makes it obvious that these constraints placed a heavy burden on her teaching. One example is found in the following excerpt from a stimulated recall transcript:

> "So. I have three children with very disparate abilities, and if I had a more homogeneous class I would not group these three children together. So,

it's one of the constraints that's placed upon me by the composition of the class...and...I am not happy with the results...but I have not been able to figure out a solution for it."

This case study raises serious questions about the kinds of constraints that are placed on teachers. It is not possible to tell from one case study whether all teachers must contend with similar problems or even if these constraints are more characteristic of special education classes. However, it is a topic that bears further investigation. The discovery that large numbers of teachers have to deal with such overwhelming constraints as the ones we identified in our case study would have serious implications for educational policy. Indeed it may be one reason why teachers continue to find it difficult to make a difference in the education of our nation's students.

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APPENDIX A

CATEGORIES THAT CONSTITUTE THE FUNDAMENTAL STRUCTURE OF TEACHING

A. Pedagogical Principles

(1) Relating new information to something they know
(2) Direct Instruction techniques and materials
(3) Adapting materials to the needs of the student
(4) Relating research findings to instruction
(5) Behavior analysis

B. Constraints of the Setting
(1) Diversity of students (age, characteristics)
(2) Previous structure (aide doesn't enforce rules)
(3) Outside sources (pull-out schedule, holiday, off-day)
(4) Regular curriculum (poorly designed or difficult materials, etc.)

C. Learner Characteristics
(1) Severely language-disabled
(2) Leaning-disabled
(3) Attention deficit
(4) Autistic
(5) Poor spellers
(6) Can't follow directions

OPERATIONAL STRUCTURE OF TEACHING ROUTINES

A. Monitoring, analyzing, reviewing-Assessing strengths and weaknesses of student in order to determine the level of a skill at which a student can perform satisfactorily.

B. Rules and Procedures-Aids devised to maintain classroom order and for learning skills and strategies.

C. Drill, Practice, Cuing-Activities designed to promote learning of skills and strategies.

D. Checking and Correcting-Procedures designed to check learner's understanding and to correct errors, that is, to provide feedback to the learner.

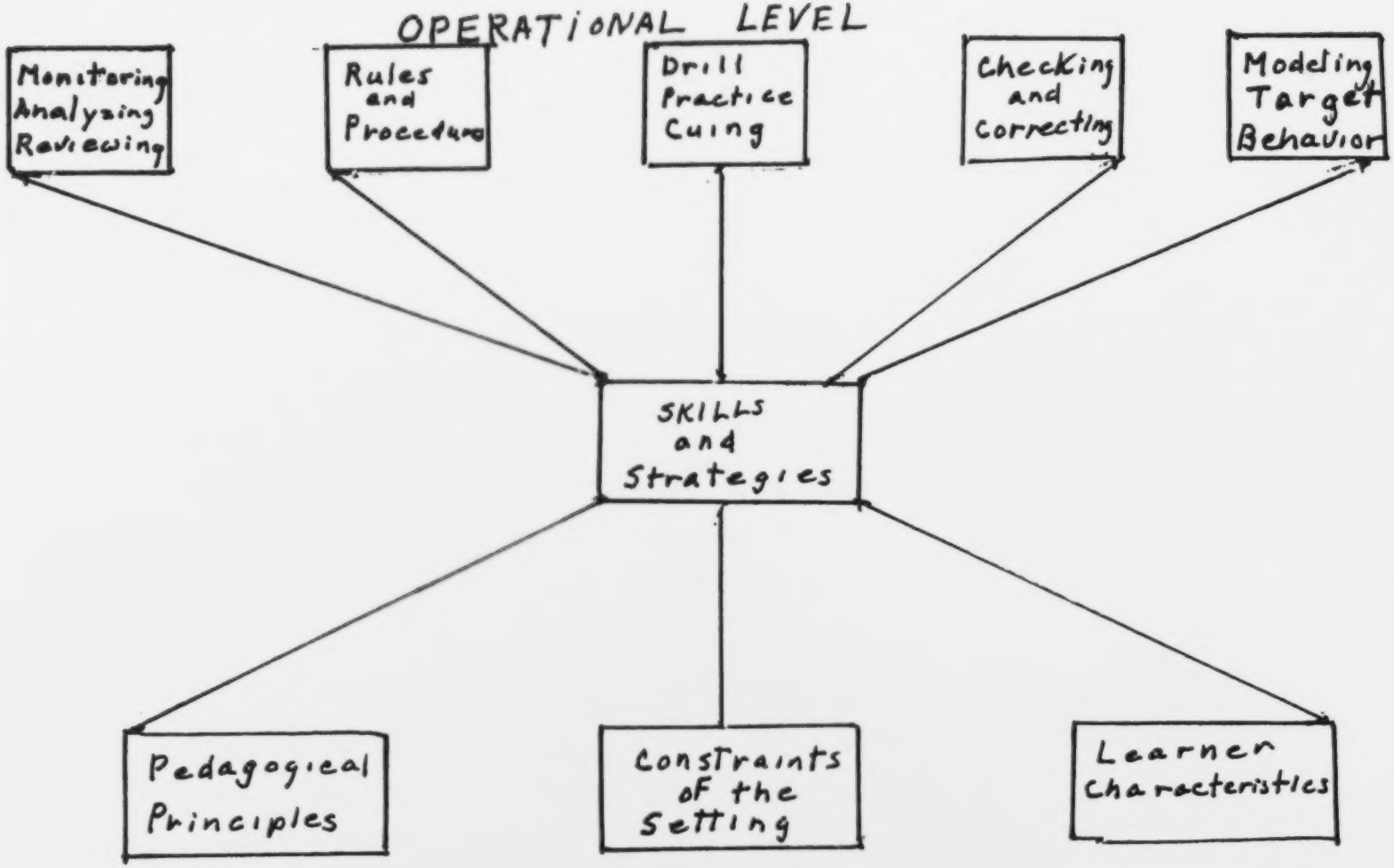
E. Modeling-Productions by the teacher of the target behavior to serve as a guide to the learner.

THIS STRUCTURE ALLOWS THE TEACHER TO IMPLEMENT HER PRIMARY OBJECTIVE, INSTRUCTION IN THE FOLLOWING SKILLS AND STRATEGIES:

Kinds of skills and strategies

sight words
word comprehension
vowel sounds
decoding
comprehension
phonetic spelling ability
study skills
inferential thinking
deductive thinking
(following) written directions
problem-solving
rounding off numbers
read(ing) tables and charts
learning to estimate
reading maps
reading and following directions
manners (sneezing)

Appendix B


OPERATIONAL LEVEL
Monitoring Analyzing Reviewing
Rules and Procedure
Drill Practice Cuing
Checking and Correcting
Modeling Target Behavior
SKILLS and Strategies
Pedagogical Principles
Constraints of the Setting
Learner Characteristics
FUNDAMENTAL LEVEL

Appendix C

Fundamental Level

	#C.S.	#P.P.	#L.C.N.	Total
Phonics Nov. 1	1	7	6	14
Math Nov. 6	3	3	7	13
Dister Nov. 14	3	5	9	17
Mult pass Nov. 15	4	12	5	21
Total	11	27	27	65

Operational Level

	#D.P.C%	#C.C. %	#P.P. %	#M.A.R%	#M.T.R%	Total	%
Phonics Nov. 1	11 .38	8 .28	4 .14	3 .10	3 .10	29	.31
Math Nov. 6	7 .29	7 .29	2 .08	6 .25	2 .08	24	.25
Dister Nov. 14	8 .40	5 .25	3 .13	3 .13	1 .05	20	.21
Multi pass Nov. 15	4 .18	6 .27	1 .05	4 .18	7 .32	22	.23
	30	26	10	16	13	95	

see Appendix A for definitions of routines in Operational Level

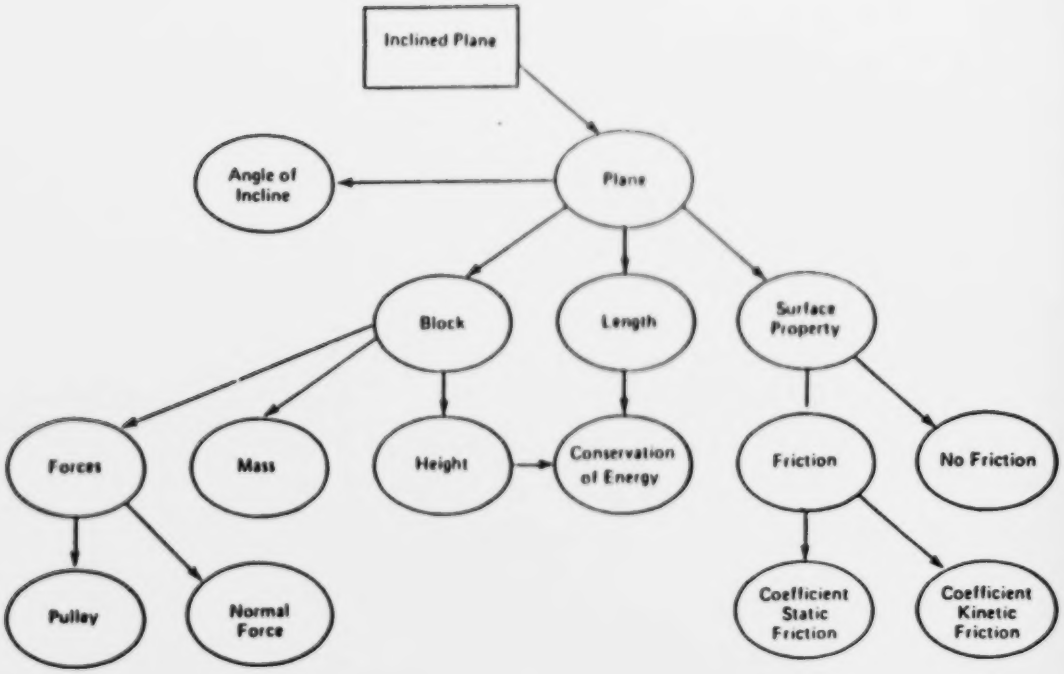


Figure 1. Network representation of a novice's schema of an inclined plane (from Chi, Glaser, & Rees, 1982).

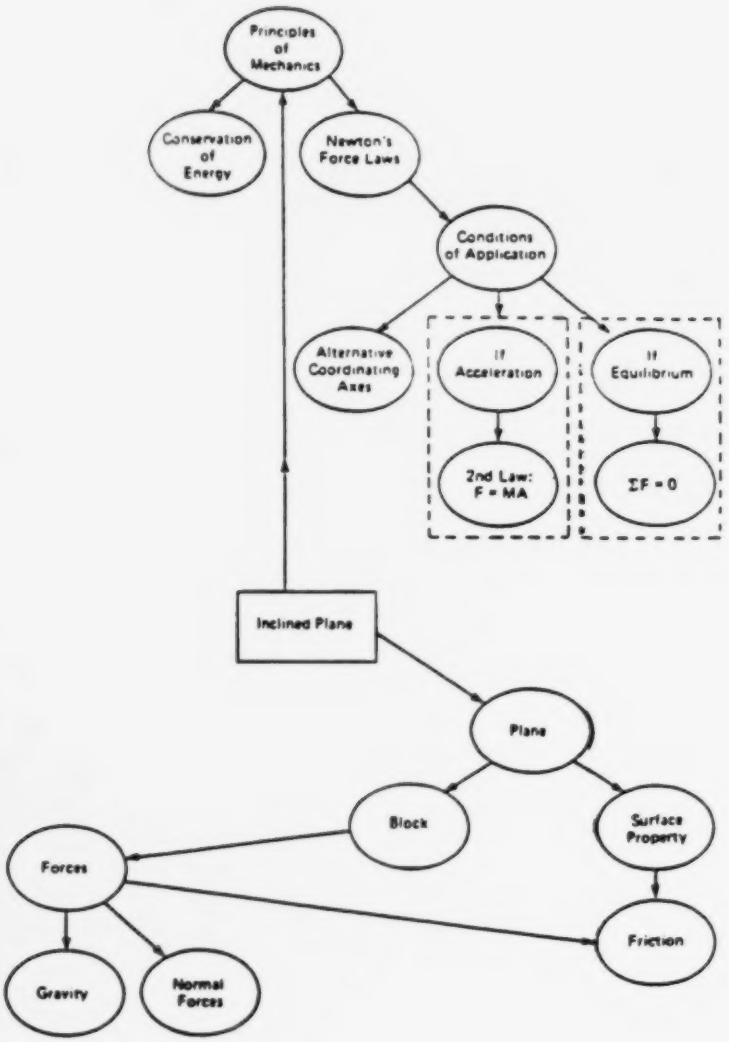


Figure 2. Network representation of an expert's schema of an inclined plane (from Chi, Glaser, & Rees, 1982).

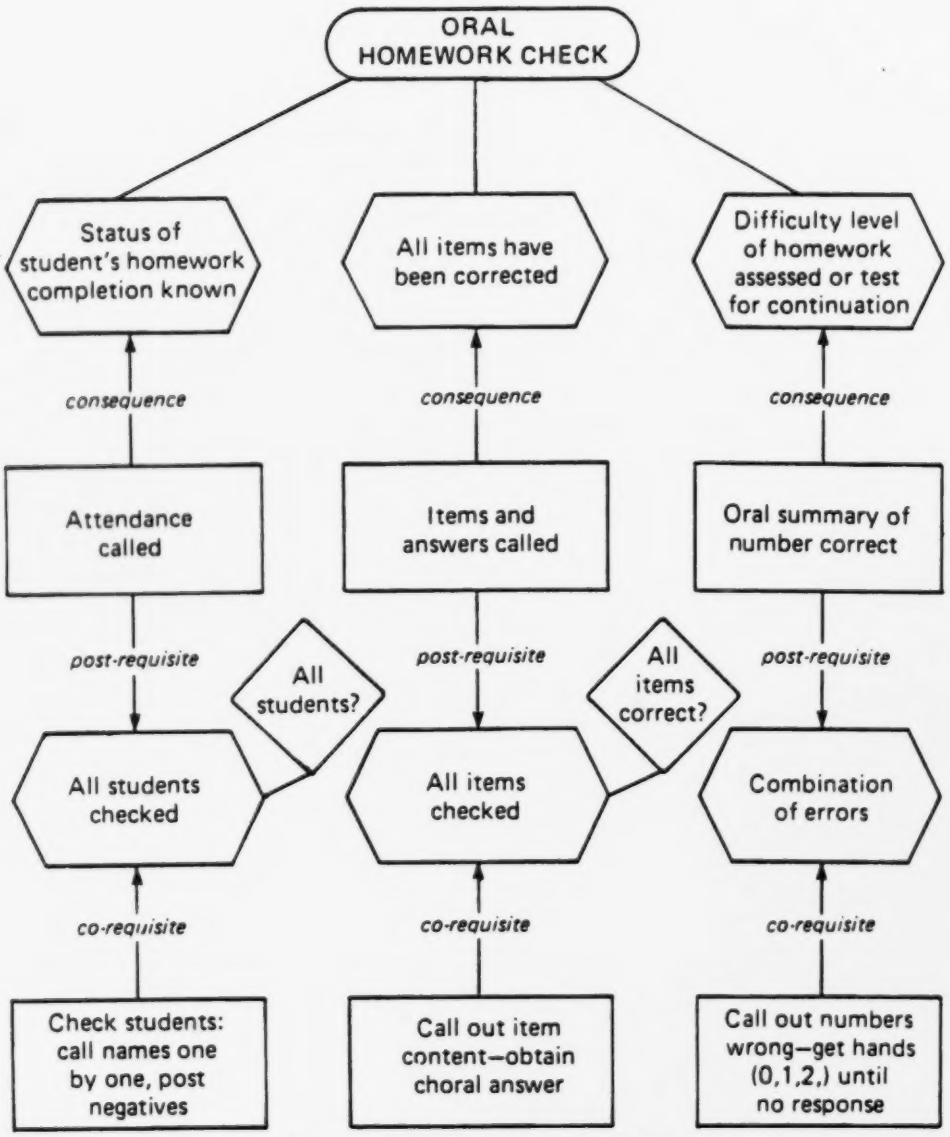


Figure 1. Planning net for oral homework check.

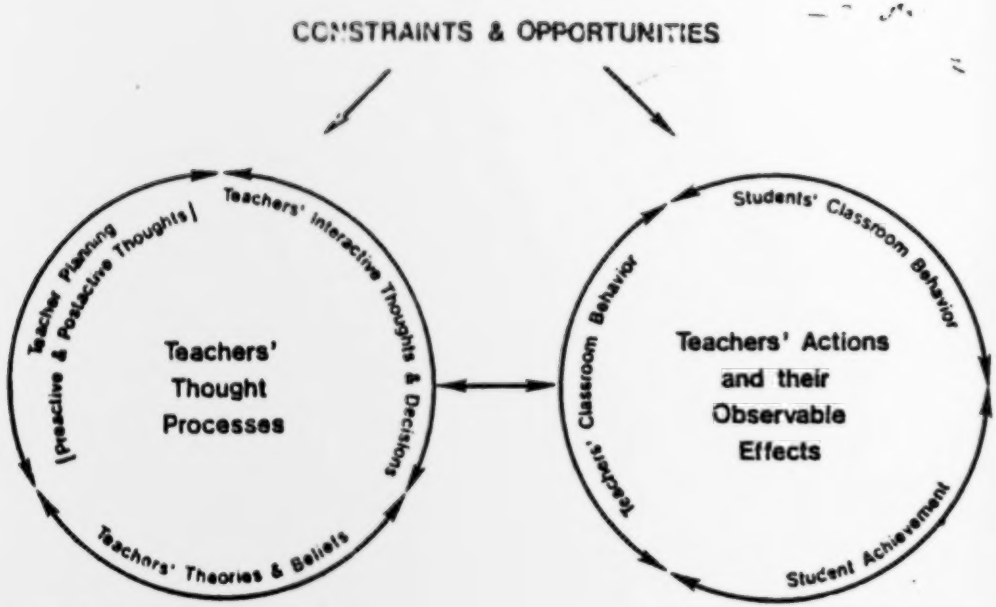


Fig. 9.1. A model of teacher thought and action.